

As Little as One Teaspoon of Dietary Fat in a Meal Enhances the Absorption of β -carotene

Dr. Penelope Nestel and Dr. Ritu Nalubola

Provitamin A carotenoids are precursors of vitamin A. Among the 50 or so known provitamin A carotenoids, β -carotene contributes by far the most to vitamin A activity in foods because of its wide occurrence and high bioactivity. Carotenoids are not soluble in water. Instead, absorption occurs when carotenoids released from the food matrix are incorporated into so-called micelles, which are aggregates of lipids, in the small intestine. The formation of these micelles is partly dependent on the presence of fat in the intestine. Therefore, ingesting fat along with carotenoids is crucial for carotenoid absorption.^{1,2}

The importance of dietary fat at the time of β -carotene consumption has been clearly demonstrated in humans.^{3,4,5,6,7,8} β -Carotene absorption is less than optimal when no dietary fat is consumed. The addition of even a small amount of fat to a meal substantially improves carotenoid blood levels. The optimal amount of dietary fat to enhance β -carotene absorption is 3 g or more per snack or meal.^{3,8}

Not only the amount but also the type of dietary fat appears to influence provitamin A carotenoid bioavailability. The absorption of β -carotene may be lower in meals containing medium-chain triglycerides compared with meals containing long-chain triglycerides (found in some seed oils).⁹ Similarly, intestinal absorption of β -carotene is lower when consumed with sunflower oil-rich meal than with beef tallow-rich meal.¹⁰ Consumption of red palm oil or sunflower oil both had a positive and similar effect on retinol status in lactating women in a 6-month intervention trial.¹¹ Furthermore, breast milk retinol levels were maintained for up to 3 months postpartum.¹¹

Scientific evidence clearly demonstrates the importance of dietary fat at the time of provitamin A carotenoid consumption. The minimum amount of fat required, however, depends on the physical and chemical characteristics of the carotenoids as well as those of the fat. Data suggest that a minimum of 3 to 5 g dietary fat, equivalent to about one teaspoon, is needed in a meal to ensure optimal intestinal β -carotene uptake. Food-based interventions aimed at improving the vitamin A status of deficient populations should consider incorporating recommendations to increase dietary fat intake along with increasing the intake of provitamin A carotenoid-rich plant foods. Red palm oil and other vegetable oils such as coconut oil, as well as animal fats, should be explored as feasible options.

The absorption of β -carotene is affected by the type of fat ingested, but the ingestion of any fat or oil is preferable to no fat or oil consumption.

A minimum of 3–5g dietary fat, equivalent to about 1 teaspoon, is needed in a meal to ensure optimal intestinal β -carotene absorption.

Acknowledgment: This document was reviewed by Drs. Delia Rodriguez-Amaya, Saskia de Pee, Alison Draper, and Harshi Sachdev, whose comments and suggestions are greatly appreciated.

- ¹ van het Hof KH, West CE, Weststrate JA, Hautvast JGAJ. Dietary factors that affect the bioavailability of carotenoids. *J Nutr* 2000;130:503–506.
- ² Parker RS. Absorption, metabolism and transport of carotenoids. *FASEB J* 1996;10:542–551.
- ³ Roodenburg AJC, Leenen R, van het Hof KH, et al. Amount of fat in the diet affects bioavailability of lutein esters but not of α -carotene, β -carotene, and vitamin E in humans. *Am J Clin Nutr* 2000;71:1187–1193.
- ⁴ Takyi EEK. Children's consumption of dark green, leafy vegetables with added fat enhances serum retinol. *J Nutr* 1999;129:1549–1554.
- ⁵ Jalal F, Nesheim MC, Agus Z, et al. Serum retinol concentrations in children are affected by food sources of β -carotene, fat intake, and anthelmintic drug treatment. *Am J Clin Nutr* 1998;68:623–629.
- ⁶ Shiau A, Mobarhan S, Stacewicz-Sapuntzakis M, et al. Assessment of the intestinal retention of β -carotene in humans. *J Am Coll Nutr* 1994;13:369–375.
- ⁷ Dimitrov NV, Meyer C, Ullrey DE, et al. Bioavailability of β -carotene in humans. *Am J Clin Nutr* 1988;48:298–304.
- ⁸ Jayarajan P, Reddy V, Mohanram M. Effect of dietary fat on absorption of β -carotene from green leafy vegetables in children. *Indian J Med Res* 1980;71:53–56.
- ⁹ Borel P, Tyssandier V, Mekki N, et al. Chylomicron β -carotene and retinyl palmitate responses are dramatically diminished when men ingest β -carotene with medium-chain rather than long-chain triglycerides. *J Nutr* 1998;128:1361–1367.
- ¹⁰ Xixuan Hu, Jandacek RJ, White WS. Intestinal absorption of β -carotene ingested with a meal rich in sunflower oil or beef tallow: postprandial appearance in triacylglycerol-rich lipoproteins in women. *Am J Clin Nutr* 2000;71:1170–1180.
- ¹¹ Lietz G, Henry CJK, Mulokozi G, et al. Comparison of the effects of supplemental red palm oil and sunflower oil on maternal vitamin A status. *Am J Clin Nutr* 2000;74:501–509.

This publication is made possible by support from Micronutrient Global Leadership, a project of the Office of Health, Infectious Disease and Nutrition, Bureau for Global Health, U.S. Agency for International Development, under Cooperative Agreement HRN-A-00-98-00027-00 with the International Life Sciences Institute Research Foundation.

January 2003. Printed in the United States of America.

Additional copies of this and other MGL publications are available free of charge to developing countries and for US\$3.50 to developed countries. Copies may be ordered from:

ILSI Human Nutrition Institute
One Thomas Circle, NW
Ninth Floor
Washington, DC 20005 USA
Tel: (202) 659-9024
Fax: (202) 659-3617
Email: hni@ilsi.org
Internet: <http://ilsi.org>

